ual consultants to manipulate data sets that required expensive mainframe computers just two decades ago.

While personal computers have been a boon to transportation analysis, the analyst still needs to take the time to understand how to use the new tool correctly. Otherwise, traditional methods could be applied inappropriately to new issues and data. For example, it is relatively easy with a personal computer to apply the classic four-step urban travel demand forecasting process to estimate local, statewide, or national commodity movements. This could produce misleading results as shippers and carriers respond to very different forces than do households and individuals in using the transportation system. There is also a danger that some analysts will load and tabulate large data sets from CD-ROMs with off-the-shelf database packages without closely examining documentation, producing results that seem plausible but may be entirely wrong. For example, the TIUS characterizes vehicle weight in several ways; the appropriate measure depends on the application. Novice users might use the first weight variable they encounter.

These problems create an important challenge for BTS and other data providers to accelerate research on alternative forms of data presentation, modeling, and analysis, and to place significant emphasis on training. The training challenge is particularly daunting, because data customers are no longer limited to analysts in a few large agencies.

Conference participants also discussed institutional concerns, focusing on establishing public-private partnerships to coordinate data collection and access among all levels of transportation decisionmakers.

CHANGING SOURCES OF TRANSPORTATION DATA

The U.S. Department of Transportation (DOT) uses four basic sources of transportation data:

- surveys,
- reports from service providers,
- reports from government agencies, and
- administrative information from management and traffic control systems.

Surveys are often expensive, can burden individuals and businesses with paperwork, and are sometimes the least timely way to collect data, but may be the only means available in some cases. For example, few people keep consistent records of their household travel unless they are participating in a survey. Reports from service providers, such as filings by carriers for regulatory purposes, also can be burdensome, because the cost of data collection is shifted from the data-collection agency to the respondent. The least obtrusive sources of data are byproducts of management and control systems, such as counts of vehicles on a turnpike based on toll collections.

As information technology advances, unobtrusive methods of measurement are improving in both sophistication and coverage. When monitoring and control systems can be tapped, the quantity and quality of data increase dramatically while the costs and burden to the respondent plummet. For example, every ticket collected by the airlines is processed through a clearinghouse. The ticket information is used to allocate revenues when the ticketed travel is not completed on the originating airline. The clearinghouse is an excellent source of data about commercial passenger air travel geography and on ticket prices for all domestic origins and destinations. BTS is working with industry to tap the clear-

inghouse as a replacement for the current data-collection system.[13] If the clearinghouse could be used, data collection would be fully automated, thus eliminating any reporting burden on the carrier. Also, because 100 percent of the travel is measured directly and only after the travel is completed, there would no longer be errors from sampling or itinerary changes.

Switching to unobtrusive forms of data collection is not a panacea. Setup costs, both fiscal and institutional, can be high, and the nature of the data being collected may change, as illustrated by trucking data. Formerly, much of these data were obtained for highway planning purposes by stopping trucks at temporary roadside stations and weighing the trucks with portable scales. The operating expenses of temporary weigh stations limited the number of observations that could be made. The time burden placed on drivers encouraged some to avoid the scales and thus make the data less representative. By switching to weigh-in-motion sensors in the pavement, data-collection costs fell, the number of observations increased by orders of magnitude, truckers were no longer inconvenienced, and bias from scale avoidance was eliminated. The only information so obtained, however, was the weight and spacing of each axle. In the past, the driver could be asked about the load, trip origin and destination, and other characteristics. This additional information must now be obtained through surveys or other intrusive data-collection strategies.

In time, intelligent transportation systems (ITS) may allow the replacement of many surveys and carrier reports, particularly if traffic control, shipment management, and other systems can be integrated. Almost all of the information obtained in roadside interviews of truck drivers, plus other freight information, could be captured from monitoring systems that public agencies are considering to manage congestion and collect user fees. Similar information could be captured from monitoring systems used by carriers to track their vehicles, shipments, and drivers.

In the near term, however, important barriers impede full realization of the potential of ITS for data collection. First, most systems are designed to manage day-to-day or minute-to-minute conditions, in itself a challenge. Additional requirements for integration and archiving of data are often secondary, especially if integration must be achieved across organizations. There are also legal issues, privacy concerns, and limitations on the use of proprietary data that need to be resolved. Private companies are reluctant to share information with their competitors. Individuals are concerned that personal information provided to a government agency may be available to others. Public agencies are worried that data could be used against them in court; for example, observation by an agency of an unsafe condition before a crash could possibly be used by a victim to sue later for failure to correct the problem.

For these and other reasons, enormous amounts of data generated in transportation monitoring and control functions are not saved. The transportation community must continue to depend on more costly and burdensome data collection until technological and institutional issues can be resolved.

Improvements need to be made in the traditional forms of data collection. The use of computers for telephone and personal interviews can reduce costs and respondent burden by speeding up the interview, improve data quality by providing immediate feedback for unlikely answers, and improve timeliness by automating the com-

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[13] The BTS Office of Airline Information currently collects the data by sampling every 10th airline ticket sold. Airlines submit computerized ticket images or special data files. The results can be affected by sampling error and by changes in passenger itineraries after the ticket is purchased.

pilation of field data. The Census Bureau is gaining extensive experience with using computer-aided interviewing, and the Federal Highway Administration has sponsored research on the use of inexpensive, handheld computers for data collection.

STRATEGIC RESPONSES

Reauthorization of ISTEA provides an opportunity to reinforce the benchmark data programs established in 1991, expand those programs to include critical topics such as the domestic transportation of international trade, develop new technologies for less burdensome data collection, and renew efforts to enhance the organization and sharing of information through the National Transportation Library (see box 1). BTS has proposed a three-element strategy in the Administration's reauthorization bill.

Understanding Transportation in a Globalized Economy

Responding to the enormous growth of international trade and the emergence of travel and tourism as one of the largest and fastest growing global industries, BTS proposes to: 1) measure the domestic transportation of commodities traded internationally and the domestic travel of foreign visitors; 2) monitor the condition and performance of the international transportation links between the United States and its global partners; and 3) compile and analyze information on world trends that affect the domestic transportation system. Among other activities, these efforts could include three new programs to reduce critical data gaps:

- *Survey of Domestic Transportation of International Trade.* BTS would sample import and export documents and conduct a followup survey to obtain information on the modes of transportation used, and the weight and correct geography of shipments.
- *Transborder Travel Survey.* BTS would survey domestic travel by international visitors in the United States by all modes of transportation. In the case of visitors from Canada, BTS would work with the Canadian government to obtain needed information from the Canadian Travel Survey. This data-collection program could replace a survey now conducted by the U.S. Department of Commerce that is limited to visitors leaving by commercial airline.
- *Air Cargo Waybill Survey.* BTS would sample shipping documents to measure the origin, destination, weight, and value of goods moving by air, and identify the commodity (where possible). Coverage would include the fast-growing air courier industry.

BTS will also continue to work with the U.S. Coast Guard, the Maritime Administration, and the U.S. Army Corps of Engineers to improve the quality, comparability, and efficiency of their maritime transportation data programs.

Partnerships for More Effective Information

BTS was asked by nearly 200 stakeholders at the National Conference on Information Needs to Support State and Local Transportation Decisionmaking into the 21st Century to make national data more useful at the local level, and to provide technical assistance for local data collection and analysis. The stakeholders recognized that the required effort involves federally encouraged information sharing at state and local levels as much as federally provided data and technical assistance. BTS proposes three responses.

First, BTS proposes a series of enhancements to federal data programs to improve their relevance to state and local transportation decision-

Box 1.
Expanding the Role of the National Transportation Library

The most complete, accurate, relevant statistics are of little use if they are not made readily available in usable forms. Information must be organized in ways that allow users to find what they seek quickly, yet encourage users to find other relevant information that was not part of their original search.

The transportation field today consists of professionals working in a complex amalgam of disciplines with rapidly changing knowledge bases. Transportation agencies not only must have engineering expertise to carry out construction and maintenance projects, but must also have the wherewithal to perform or evaluate economic analysis, demographic and social science research, cartographic and spatial analysis, statistical analysis, information management, and many other specialties. These agencies are staffed not just by engineers, but by geographers, demographers, economists, market researchers, computer scientists, business administrators, and lawyers.

There is an acute need for a systematic approach for organizing transportation-relevant information from each of the component fields, and making pertinent literature and data accessible and broadly available. In many fields, libraries perform this organizational function. For example, the National Library of Medicine (NLM) is far more than a collection of books and magazines. It helps organize and makes accessible the knowledge base of the medical profession, works with a network of libraries to disseminate that knowledge in many print and electronic forms, and provides the corporate memory of past successes and failures from which lessons for the future can be drawn. Carrying out these functions requires resources: the budget of the NLM exceeds the amount spent on *all* major data-collection programs by administrations within the Department of Transportation by 50 percent.

The transportation community has chronically underinvested in these broad library functions. Federal collections have been lost by agency closures (as in the case of the Interstate Commerce Commission) or severe budget reductions. State and local agency libraries are not effectively networked and suffer similar budget woes. No single organization in the transportation field has the mandate to provide leadership in capturing and preserving transportation's corporate memory, and organizing and sharing the knowledge base in useful ways.

The National Transportation Library (NTL) is a modest beginning to redress this problem. Started by the Bureau of Transportation Statistics (BTS) as an Internet site, the NTL was designed as an electronic depository for documents and data from all levels of government. Most documents in the library are provided by state departments of transportation and metropolitan planning organizations. The library is a platform on which planners and researchers from state and local agencies can share accomplishments and experiences directly.

For the NTL to achieve its potential, BTS must expand the electronic collection, begin identifying and capturing the physical collections of agencies that can no longer maintain them, establish cataloging and related services, and work with university and agency libraries to establish a network for sharing the collections, experiences, and knowledge of the transportation community.

makers. One element would be to extend the national Transportation Satellite Account and related economic analysis methods to the state level. Methods and data would be provided to help states determine economic levels of transportation investment, prioritize transportation projects across modes based on economic criteria, and forecast transportation revenues.

Second, BTS proposes a program of technical and financial assistance to state agencies, metropolitan planning organizations, universities, and others that integrate local data collections and analyses among themselves and with national counterparts. The program would build repositories of transportation data and information on the Internet, develop better methods of data use and analysis, and work with the private sector to ensure that DOT provides American businesses with meaningful information in an appropriate format in a timely fashion. The program would include grants to enhance the local capacity for data analysis, implement the National Spatial Data Infrastructure mandated by Executive Order 12906, and encourage data sharing through the National Transportation Library.

Third, BTS proposes to develop, with universities and others, methods of transforming raw data from electronic data interchange systems, traffic control systems, and other forms of intelligent transportation systems into statistical information of wider utility than the purpose for which it was originally collected. These technologies offer major opportunities to improve timeliness of many kinds of statistics and minimize the burden to the public of responding to government requests for information. Both technical and institutional issues, however, must be resolved to turn operational data into an effective information resource for transportation planning and policy analysis at all levels of government.

Performance Indicators

In response to requests for assistance in developing measures to support the Government Performance and Results Act, and to requests by states and metropolitan planning organizations for help in developing performance measures for their own purposes, BTS proposes a program of research, technical assistance, and data quality enhancement to support performance measurement. Research is needed to establish a national system of performance indicators, and to update and extend the studies of program evaluation methods to transportation issues in the 1990s. BTS also proposes to establish a clearinghouse and other forms of technical assistance to help states and metropolitan planning organizations develop their own performance measurement methods. Data quality enhancement is needed in several programs sponsored by BTS and other DOT modal administrations to meet the validity and precision requirements of performance measurement. Both more timely performance measurement and improved data quality would be served by implementation of an annual vehicle use survey and by an annual version of the Nationwide Personal Transportation Survey.

THE BOTTOM LINE

The extent to which BTS pursues these strategies will depend on the funding made available by Congress. If successfully pursued, these strategies will enable BTS to measure in a more complete, accurate, and timely manner the importance of transportation (including transportation's positive and negative consequences) and to provide insights to decisionmakers on how to make transportation better unite what geography divides.